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Art. VIII.—*Note on Cretaceous Strata in the Purari Valley, Papua.*

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The phragmacone of a belemnite was found in the upper Purari Valley in January, 1894, by Sir William MacGregor, (1). No further geological observations were made in that area until 1940 when Cretaceous strata were found by the present writer. It now appears that there are extensive outcrops of Mesozoic rocks in the area between Hathor Gorge and the Paw Valley, which lies some 15 miles east of the gorge on the left bank of the Purari. To date, only four field days have been spent on these exposures, so that our knowledge of the structure and succession is still rather rudimentary. The available data concerning these rocks are presented on a plan of the Paw Creek area (fig. 1).

Four straight sections have been measured, all within the same stratigraphic interval of about 6,000 feet. There is no direct evidence of fault repetition in this thickness, but some anomalous dips and disturbed strata have been noted and the examination has not been sufficiently thorough to deny the possibility of some faulting which might affect the observed thickness. However, a thickness of over 5,000 feet is found both in Sisa Creek and in the Paw Creek sections, and it is unlikely that detailed mapping would reduce the outcropping thickness of Lower Cretaceous strata to less than 5,000 feet, with the base still not exposed.

The sequence consists of massive or thick-bedded sandstones, and dark thin-bedded mudstones. The sandstones are dark-coloured and very hard, and in the field were thought to be tuffaceous, and described as greywackes. A typical sample (112) was examined in thin section, and found to consist almost entirely of materials of volcanic origin, not noticeably worn. The slide consists largely of plagioclase in subeuhedral forms. Quartz is present in angular grains, but it is quite subordinate to the plagioclase. Magnetite is common and apatite in small crystals is

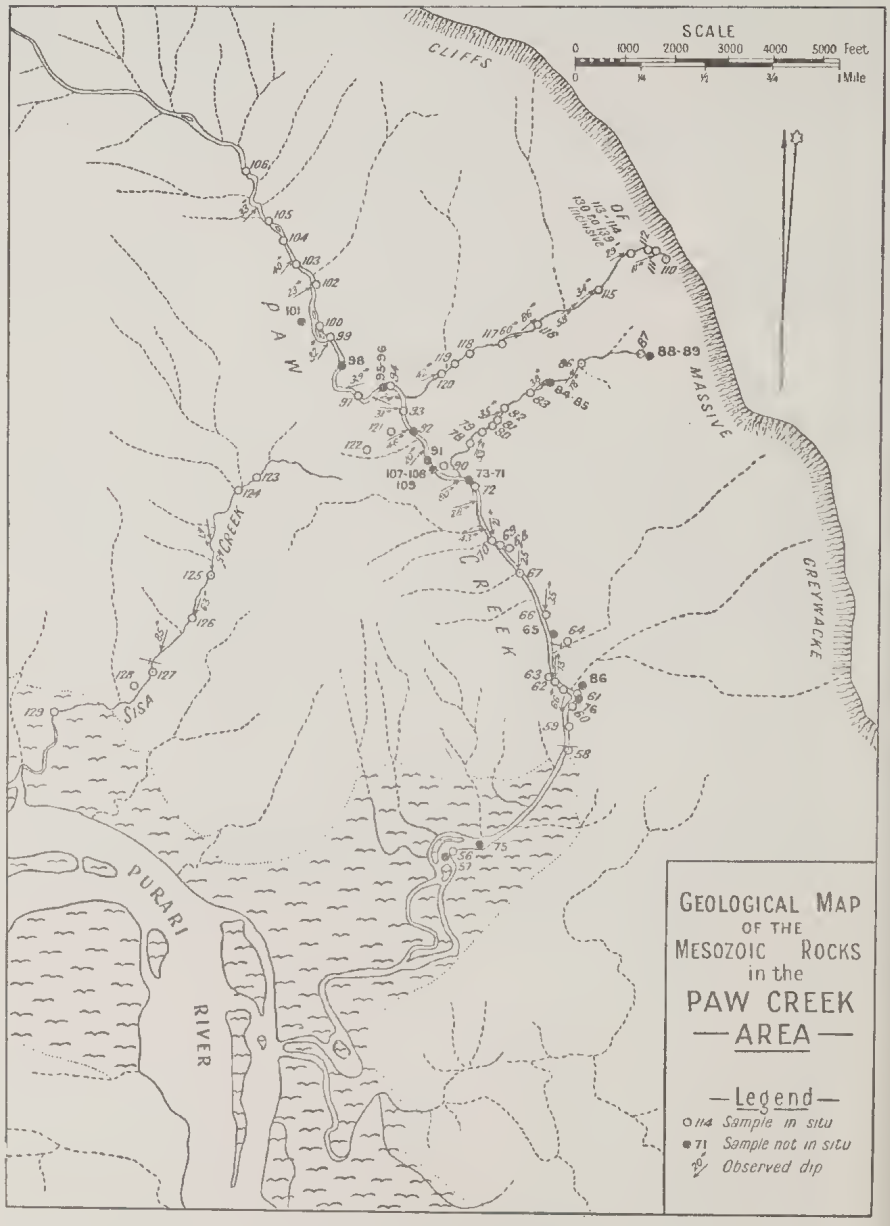

Fig. 1.—Paw Creek Area.

(Co-ordinates of south-west corner of map are 145° 56′ E., 6° 56′ S.)

"For the figure **86** on the lower portion of Paw Creek read **186**."

present. There is a good deal of interstitial chlorite with epidote, but no real groundmass. Former ferro-magnesian minerals are represented mainly by their decomposition products, but a few ragged pieces of hornblende are present.

The sandstones are usually unfossiliferous, but one richly fossiliferous horizon was found packed with molluscan material. This horizon has been called the *Exogyra* bed. It is not more than 10 feet thick. Associated with it are thin bands of biscuity shales with indeterminate plant remains. The *Exogyra* bed has only been found along the north-east side of Paw Creek Valley about 1,000 feet from the top of the cliffs, which indirect evidence suggests may be capped with Eocene *Lacazina* limestone.

A meagre fauna of foraminifera and ostracoda and echinoid spines was found in the mudstones by Dr. Glaessner (2). He also reports that the *Exogyra* bed contains *Exogyra* cf. *couloni*, *Ostrea*, and a gastropod and a pelecypod not determinable on the samples available. Both assemblages are determined by him as of Aptian-Albian age.

Overlying the Cretaceous rocks are lower Tertiary strata which in different sections rest on different horizons of the Cretaceous beds. Thus on the north-east side of Paw Creek 3,700 feet of dominantly arenaceous strata with the *Exogyra* bed about 1,000 feet from the top, are present below the Eocene. On Sisa Creek only 2,600 feet of arenaceous beds are present beneath the *Lacazina* limestone, and the *Exogyra* bed is not present. On the lower part of Paw Creek itself, only 1,100 feet of the arenaceous beds are present followed by limestone. Again the *Exogyra* bed is missing. In Noakes's Chimbu section (4) on the other hand, the stratigraphic equivalents of these Paw Creek beds, including the molluscan bed, are followed by a considerable development of Cenomanian strata, before the *Lacazina* limestone is reached. While some of these relationships are possibly complicated by faulting, it is difficult to escape the conclusion that a strong erosion interval amounting probably to angular unconformity separated the Cretaceous and Eocene in the Purari area. No angular unconformity has so far been observed in the field.

Paw Valley Samples not *in situ*:

The material collected not *in situ* in the Paw Valley, falls into six categories:

(1) Material definitely derived from the *Exogyra* bed (samples 84, 85, 88, 89).—These samples occur in a scree slope at the foot of a cliff in which the *Exogyra* bed is known to outcrop, and they are identical in lithology and fauna. They need no further comment.

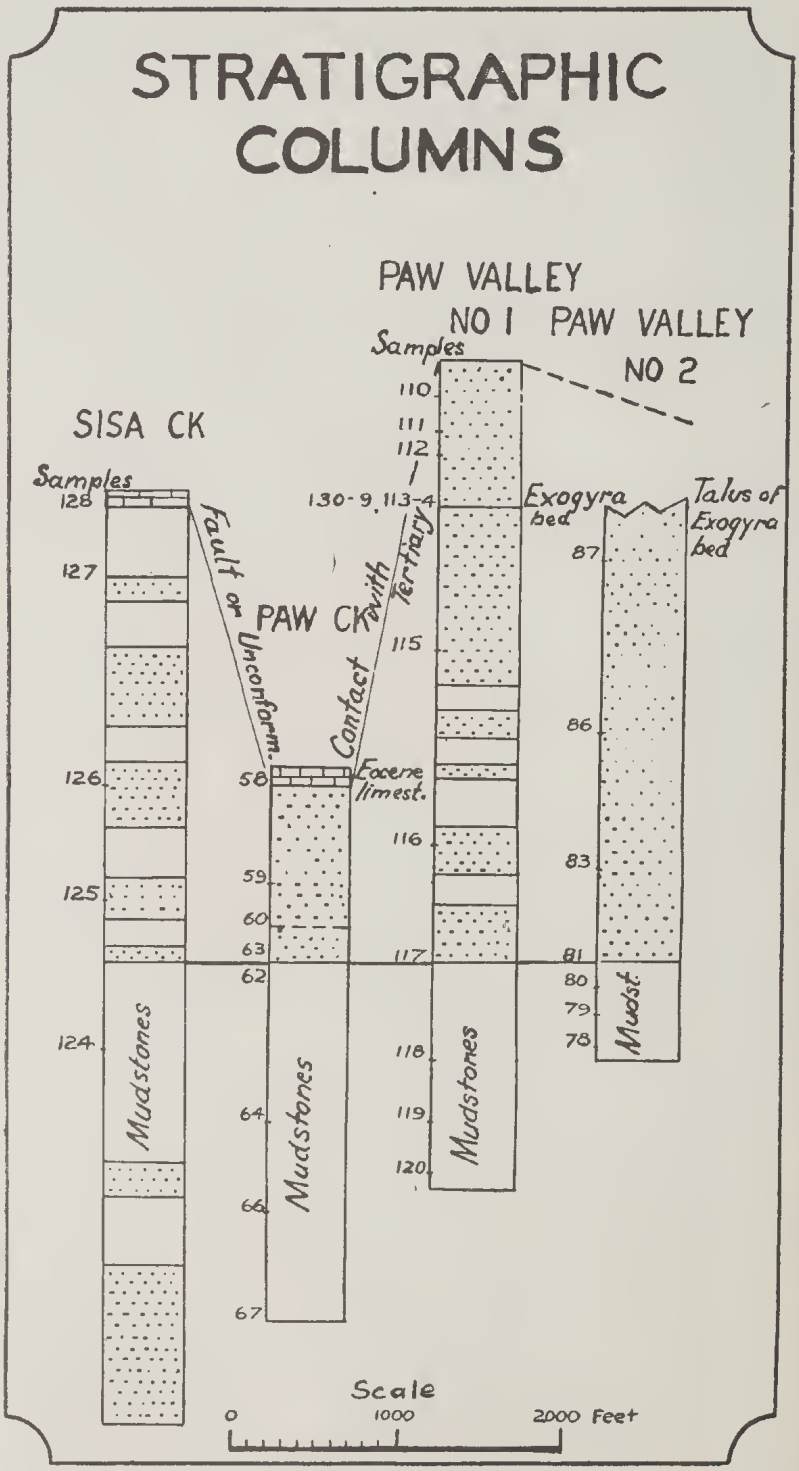

Fig. 2.—Paw Creek Area.

(2) Belemnite-bearing sandstone (sample 186).—A large belemnite was found in an otherwise barren sandstone block in the Paw Creek bed (for locality see map). It could not have travelled far for the belemnite was quite loosely attached to the sandstone. The belemnite was determined by Dr. Whitehouse as *Tetrabelus* n.sp. It is now described by Dr. Glaessner as *Tetrabelus macgregori* after the distinguished pioneer who half a century ago first recorded the presence of belemnites and Mesozoic strata in this part of New Guinea.

There is no reason to believe that the belemnite belongs to the *Exogyra* bed itself; it seems more probable that it was derived from one of the sandstones which are not generally fossiliferous. Near where the belemnite was found a molluscan sandstone was found (sample 61), carrying large numbers of an oval pelecypod referred by Glaessner to the genus *Pseudavicula*. This has a different lithology from the *Exogyra* bed, and the rest of the loose boulders, though the genus is present in other samples. Like No. 186, this sample is soft and little abraded and does not appear to have travelled far.

(3) Plant-bearing material (samples 75, 76).—A couple of well-worn pebbles of biscuity shale containing plant remains were found in the bed of Paw Creek. Their source is apparently somewhere among the strata in the Paw Valley, which as far as is known, are all Cretaceous, except perhaps a capping of Eocene limestone on top of the range overlooking it on the north-east. Plant-bearing beds of not very different lithology were found *in situ* in close association with the *Exogyra* bed, but the plant remains there were very broken with no recognizable pinnules. Samples 75 and 76 were sent to Dr. A. B. Walkom, who reported that they are "too fragmentary for very accurate determination. They represent portions of pinnae, usually with several elongated, somewhat wedge-shaped pinnules with venation of a general sphenopteroid type. Thus they belong to a species of the form-genus *Sphenopteris*. Of the species known to me (Walkom) as occurring in Australia, the Purari River specimens show some resemblance to *Sphenopteris erecta* (Tenison-Woods) which has been figured (Queensland Geological Survey, Publication 263, Plate 5, figs. 4 and 5) from the Burrum series of Queensland. The Burrum series is of Cretaceous age. . . ."

(4) *Lacazina* limestone (samples 56, 73, 74, 128).—Two specimens were collected from boulders of *Lacazina* limestone in the bed of Paw Creek about 4 miles from the mouth. They are both from fairly large though well-worn boulders, and occur in an area believed to be entirely Mesozoic. The only reasonable interpretation of their occurrence seems to be that the Eocene limestone must cap the range on the north-east side of the valley at least in some parts, and that the material has fallen and been

transported down the mountain side to the stream bed. If this interpretation is correct, the nearest possible point of origin is over a mile away, and 2,000 feet or more above.

(5) Cone-in-cone structure (sample 92).—In several places in the Paw Valley pieces of hard shaley rock were found showing well developed cone-in-cone structure. This has apparently been derived from the Cretaceous strata, but was not observed *in situ*.

(6) Molluscan calcareous sandstone (samples 57, 65, 75, 77, 91, 98, 101, 107, 108, 109, 140).—At several points on the floor of the valley both near the head and near the mouth a large number of well-worn blocks of hard calcareous sandstone packed with fossils was found. These have a different lithology from the *Exogyra* bed, which is softer and much less limy, and there is no definite reason to assume that they belong to the same horizon. However, no blocks of this material were found in either of the tributary creeks where the *Exogyra* bed is known to outcrop. It may be, however, that the *Exogyra* bed is a facies of the same bed as yielded the other samples, and that it is for this reason that the calcareous type was not found in the section or creeks containing the *Exogyra* bed. In any case, the horizon of the Molluscan material cannot be very different from that of the *Exogyra* bed. There is a fair amount of variation between the many blocks of this group. A fine-grained type is packed with small gastropods, and approaches in character towards a hard blue limestone. Other types have more pelecypods. Another type is quite pebbly. According to Glaessner, the pebbles consist of hard grey marl, red and dark cherts, quartz, &c., and some phosphatic nodules.

The following molluscs have been determined by Dr. Glaessner from these samples.—*Trigonia, Cardium, Ptychomya, Pseudavicula, Ostrea, Mytilus, Alaria, Nerinea,* and *Tetrabelus macgregori*. Several other genera are present, but not sufficiently well preserved to be determined.

These molluscan beds are of considerable interest because the rock is hard and water-worn boulders of it have a characteristic conspicuous lithology which draws the attention even of the non-geologist passing it in the stream, with the result that it has been found over a large tract of country. If the doubtful cases are included it extends from near Kerema across the middle Purari to the Waghi Valley, and westwards as far as the Strickland.

(*a*) Numerous samples (15–26 inclusive, and 33) of these molluscan beds were collected by the writer in the bed of Wabo Creek. The lithology is identical with the Paw Creek material. Here it is associated with numerous large blocks of silicified wood, some of them a foot or so in diameter (sample 26F). The

molluscan beds were not found *in situ* for the section examined by the writer there did not reach them, but it was clear from structural relationships that the molluscan material must be derived from an horizon not very far below the Eocene limestone.

(*b*) Several samples were found in the Wheian Valley by the writer in 1939 (samples 69A–69F). Here again the structure is such that it is apparent that the molluscan beds cannot be very far below the lowest Tertiary beds. At the base of a section measured between the Wheian and Pio rivers, oyster bearing beds were found *in situ*, though not well preserved. These are about 400 feet below the base of the Tertiary strata. In this case it was only after comparison with samples from Paw Creek that the Cretaceous age could be inferred.

(*c*) Sample 144 collected in Hathor Gorge by the writer, and a sample collected by Patrol Officer Ethell a few miles south-west of Lake Tebera, also have this characteristic lithology.

(*d*) Further afield it is interesting to note that E. R. Stanley's description (3) of "dark calcareous sandstones and bluish-grey limestones containing *Orbitolites*, *Gryphaea*, *Modiola*, *Aviculopecten*, and *Belemnites*" at the "head of Karova Creek", fits very well with the lithology and facies of these other Cretaceous rocks, though subsequent work has thrown doubt on the authenticity of Stanley's locality.

(*e*) Dr. Glaessner states that a pebble of bluish-green sandstone containing abundant molluscan shells was collected by G. Barrow on the Strickland River. This pebble resembles the molluscan beds in Paw Creek. Glaessner also correlates these molluscan beds with the top of Noakes' "stage 2" in the Chimbu Valley section (4). Furthermore a fossiliferous rock corresponding closely to the Paw Creek molluscan beds was found by Mr. Vial, Patrol Officer, about 3 miles east of Mingenda.

Thus, these molluscan beds are likely to prove of great value in the correlation of the Cretaceous strata throughout a wide province. Evidence suggests that the richly fossiliferous material is confined to a narrow zone near the top of a thick section of sparsely fossiliferous sandstones and shales. Being resistant to erosion by virtue of its extra lime content, and the fossils being very conspicuous on waterworn surfaces, boulders derived from this narrow zone have been found and recorded over a wide area.

The Purari Formation:

A. Gibb Maitland has referred to the belemnite bearing strata recorded by Sir William MacGregor as the Purari beds (5). So far as the writer is aware the term "Purari beds," or "Purari formation" has not been used in any other sense in any published record. Hence it is proposed that this term be adopted.

The Purari formation as now defined is a sequence of marine mudstones and sandstones, with a thin zone near the top rich in lamellibranchs, gastropods, and occasional belemnites, which outcrops in the middle and upper Purari Valley. Its fauna is described by Glaessner, and determined by him as belonging to the upper part of the Lower Cretaceous. Its thickness has been proved to exceed 5,000 feet, but neither the base nor the top is as yet precisely determined. Fragmentary data suggest that the formation may be identifiable over a region embracing the upper Strickland Valley, Chimbu, the upper and middle Purari Valley, and possibly the hinterland of Kerema. The molluscan zone is a characteristic marker of this formation.

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